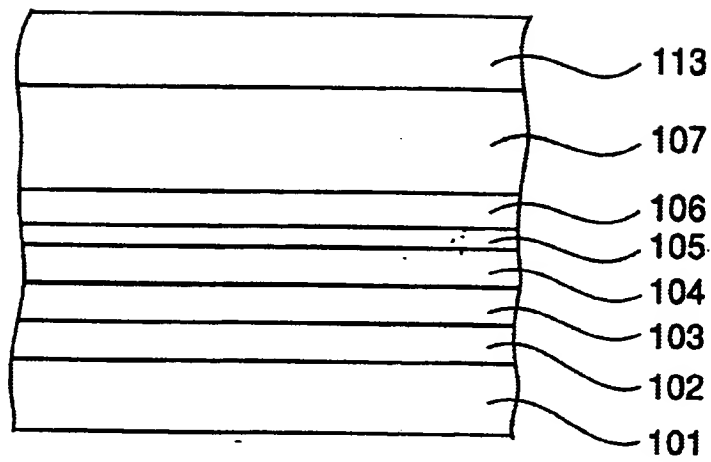
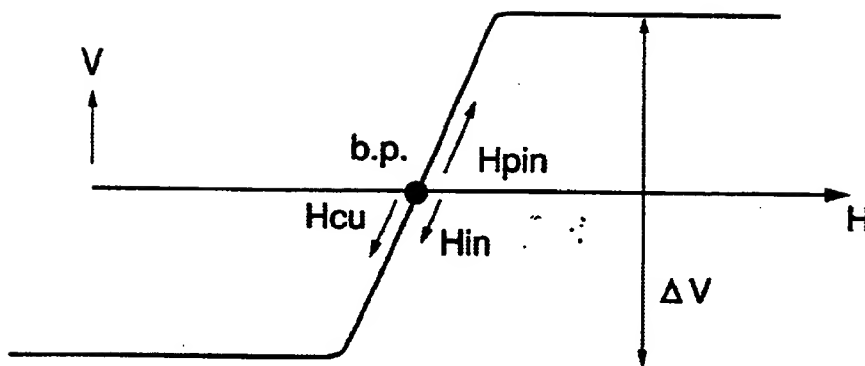


Fig.1



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Fig.2



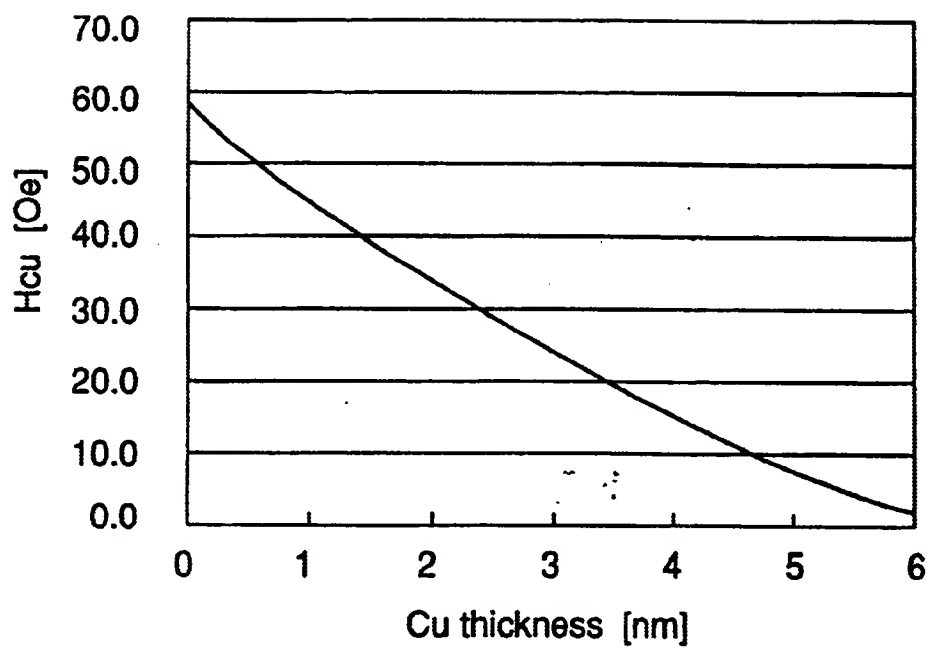
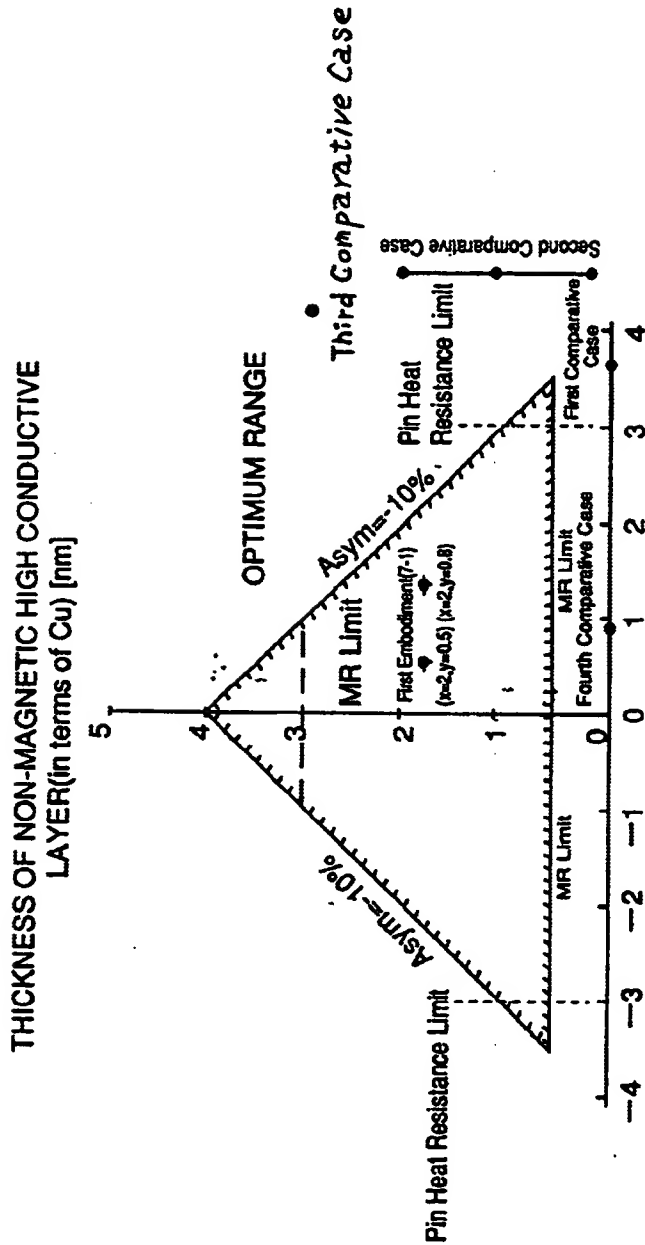


Fig.3

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Fig. 4



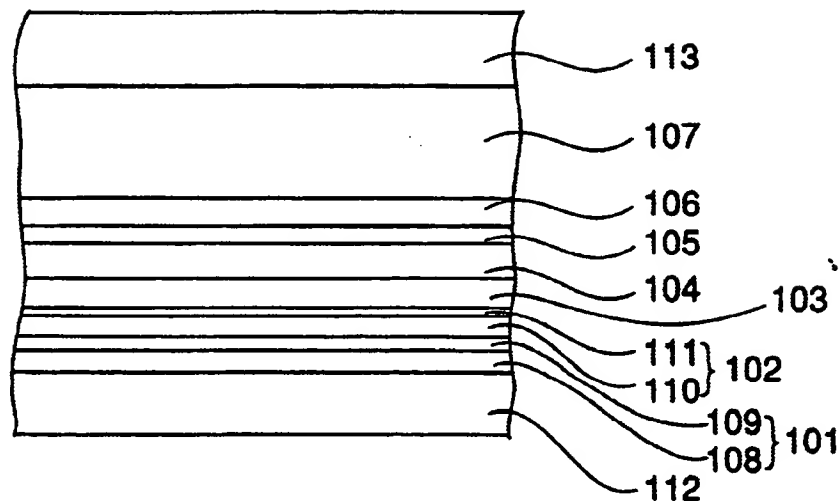
Thickness of Pin Layer in Terms of Saturated Magnetic 1T(NiFe) [nm]

In Case of Synthetic Structure $t_m(\text{pin } 1) - t_m(\text{pin } 2)$
(in terms of NiFe) [nm]

RANGE OF THICKNESS OF NON-MAGNETIC HIGH CONDUCTIVE LAYER
AND OF THICKNESS OF PIN LAYER OF THE INVENTION

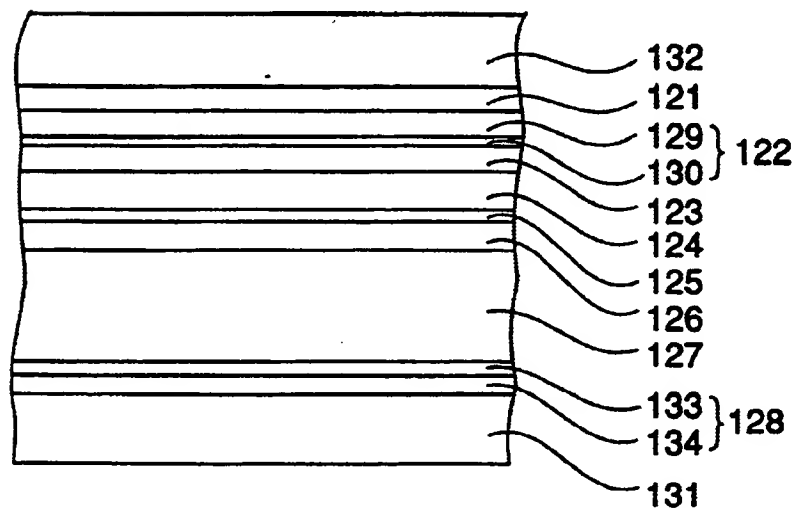
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Fig.5



EMBODIMENT IN TOP TYPE

Fig.6



EMBODIMENT IN BOTTOM P TYPE

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Fig.7A

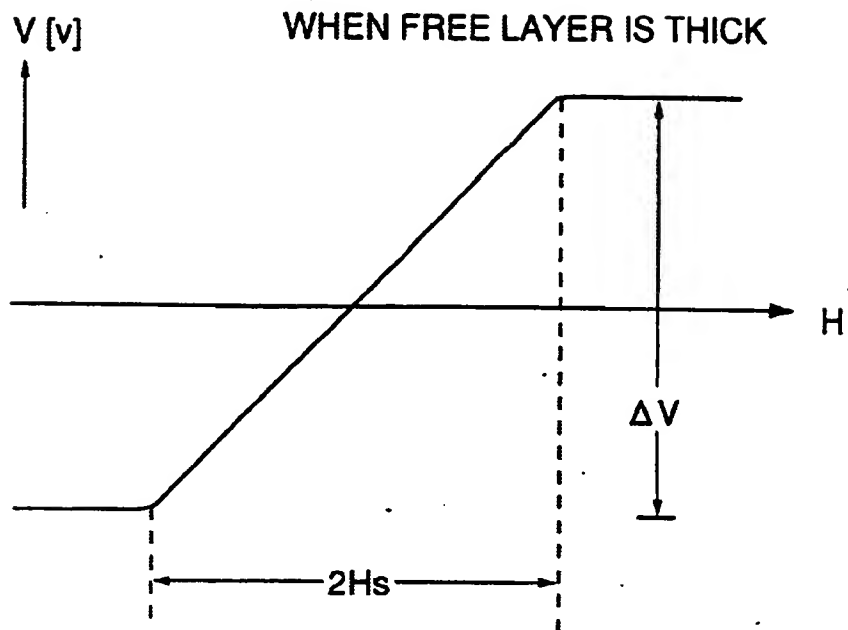
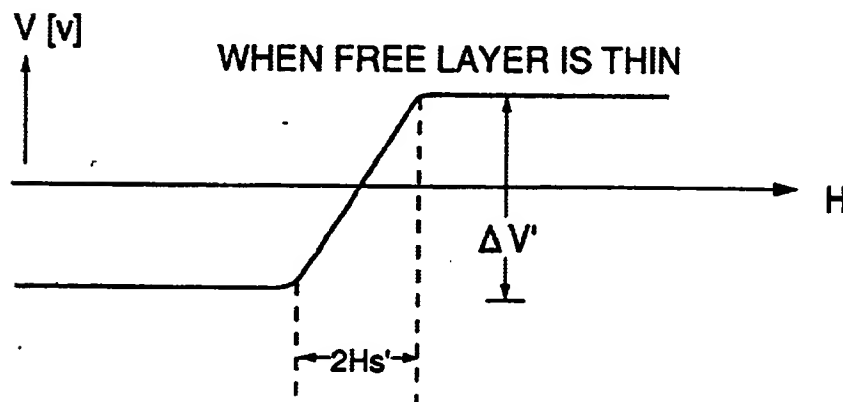


Fig.7B



PROBLEMS WHEN FREE LAYER IS THIN:

- $H_{s'} < H_s$ (Inclination becomes sharp)
 - Hard to adjust bias point
- $\Delta V' < \Delta V$ (HR ratio decreases)
 - Cannot produce output signal

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BIAS POINT IN CALCULATION [%]

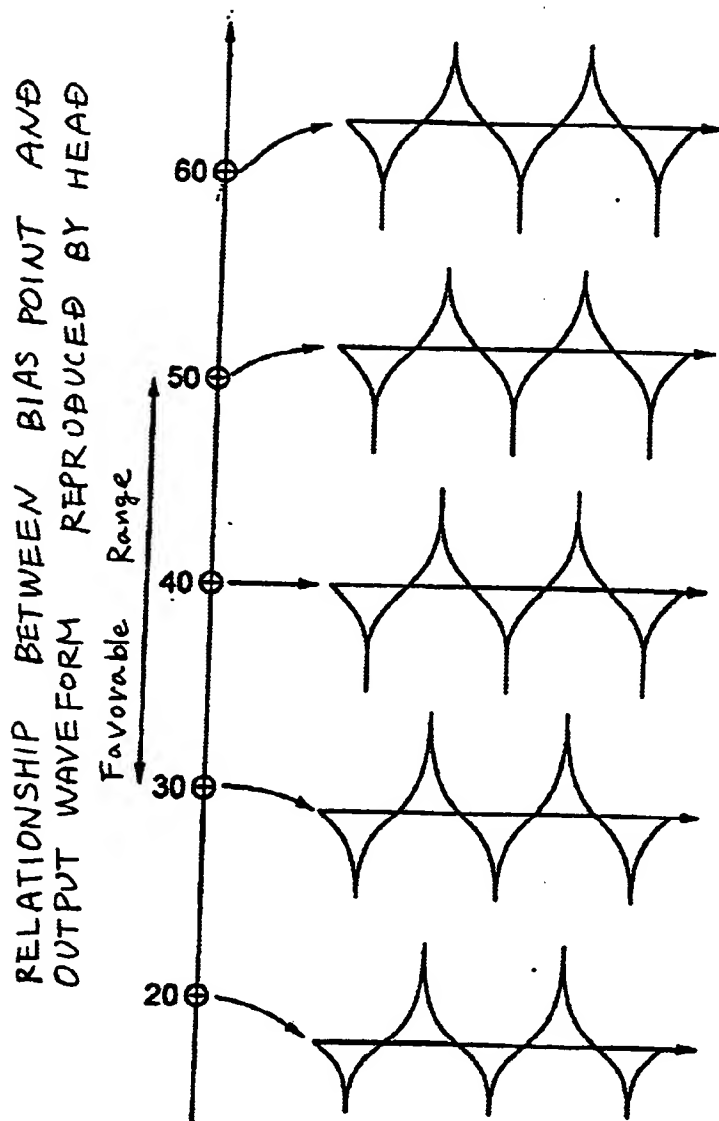
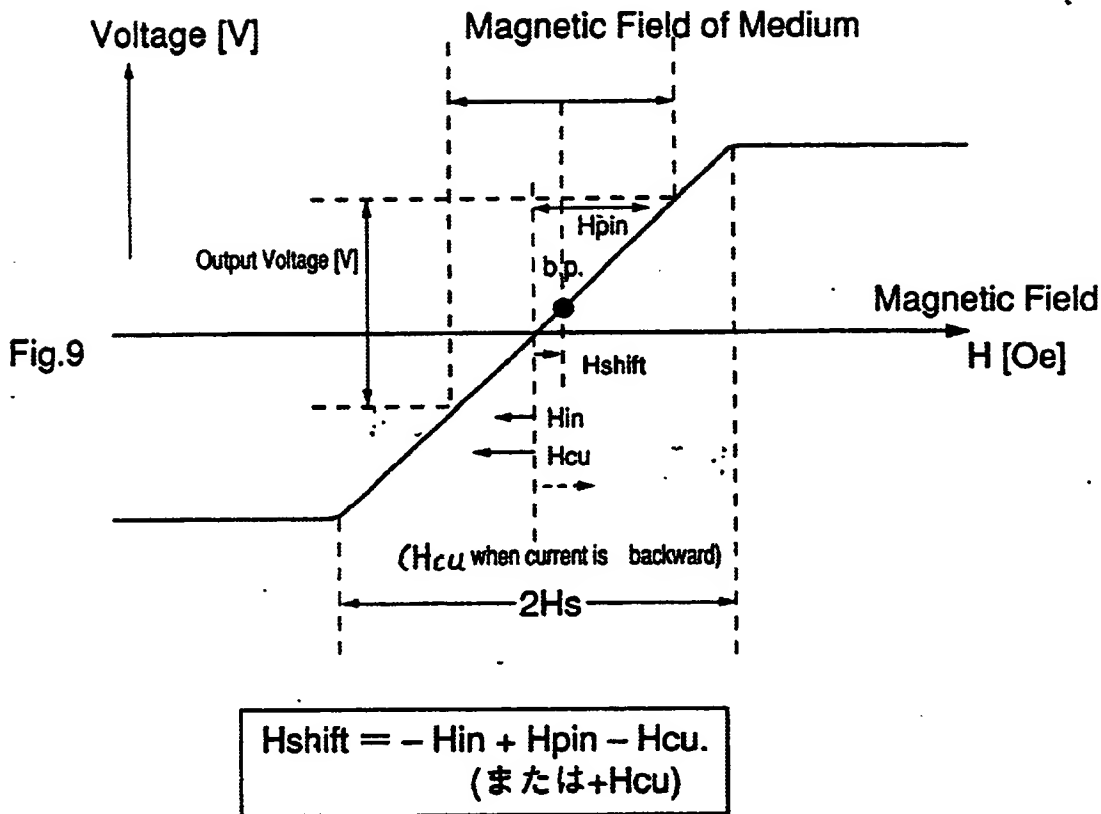


Fig. 8

FIG. 8



CONCEPTUAL GRAPH BIAS POINT (b.p.)
INDICATED ON TRANSFER CURVE

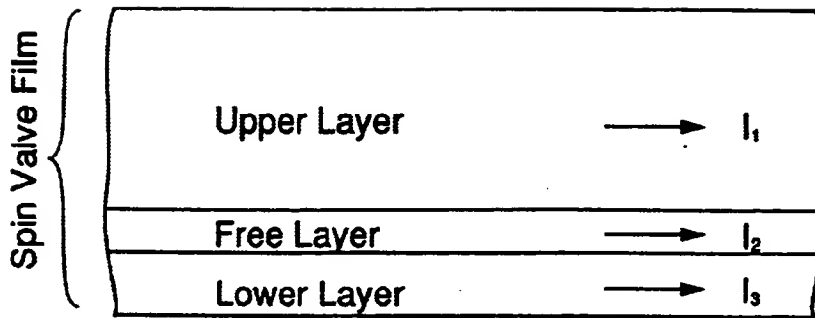


Fig.10

Sense Current : $I_s = I_1 + I_2 + I_3$ [mA]

DIAGRAMMATIC VIEW OF DIVIDED CURRENT FLOWS
OF SPIN VALVE FILM

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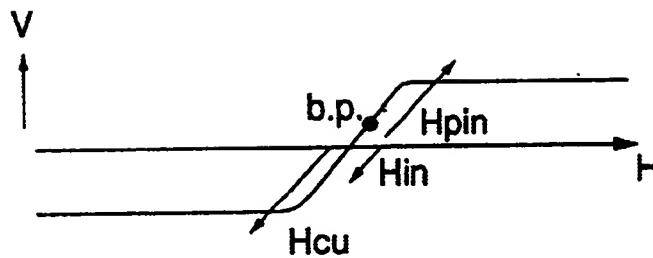


Fig.11

BIAS POINT OF FIRST COMPARATIVE CASE (No S_{pin} Filter x Normal Pin)

- (- Controllability becomes bad to bring large H_{pin} to just bias by large H_{cu} . (height dependency is large)
- Output drops because no Spin-Filter effect is utilized)

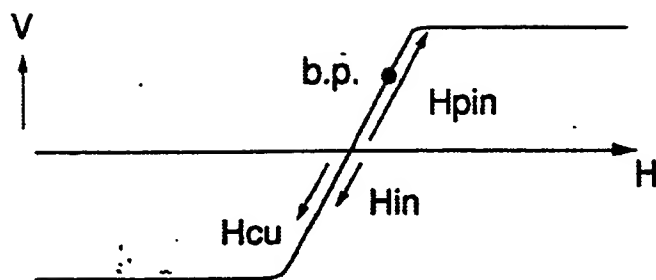


Fig.12

BIAS POINT OF COMPARATIVE CASE (^{2nd} $5\mu m$ Filter exists x Normal Pin)
(b.p. increases considerably more than 50% because Hpin is large and Hcu is small)

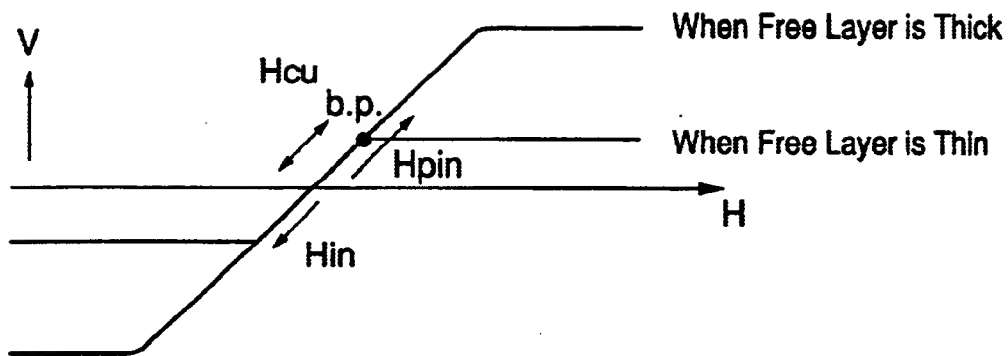


Fig.13

BIAS POINT OF THIRD COMPARATIVE CASE

(-Bias point is stabilized when free layer is thick just by decreasing H_{cu} .

-When free layer is thinned, influence of H_{pin} is large and b.p. deviates. MR also deteriorates)

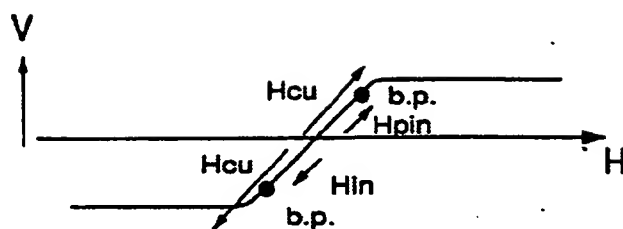


Fig.14

BIAS POINT OF FOURTH COMPARATIVE CASE (No S_{pin} Filter x Synthetic AF)

(-Just bias cannot be obtained even when current is flown in either direction when H_{in} and H_{pin} are small and H_{cu} is large near the place where $-H_{in}+H_{pin}$ is almost 50%)

MR height [μm]

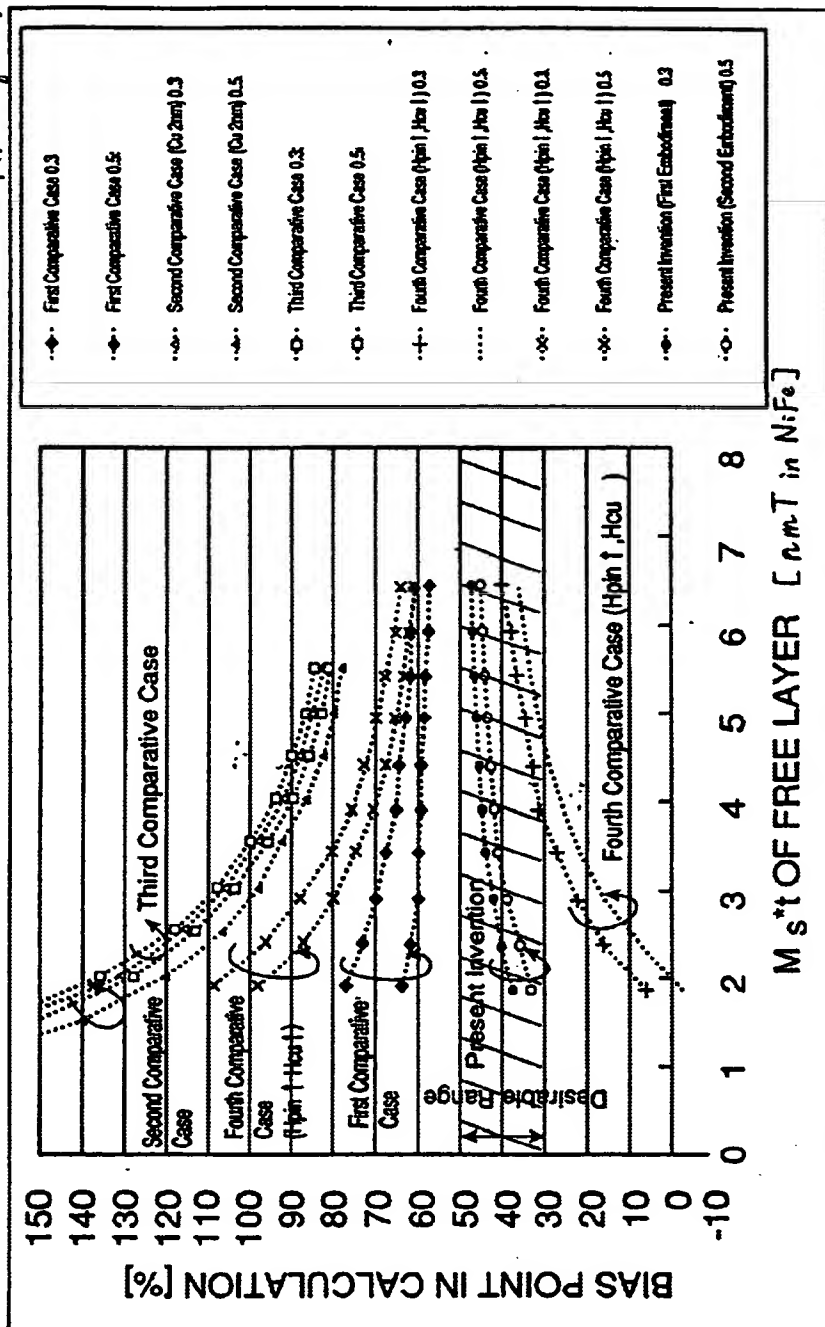


Fig.15

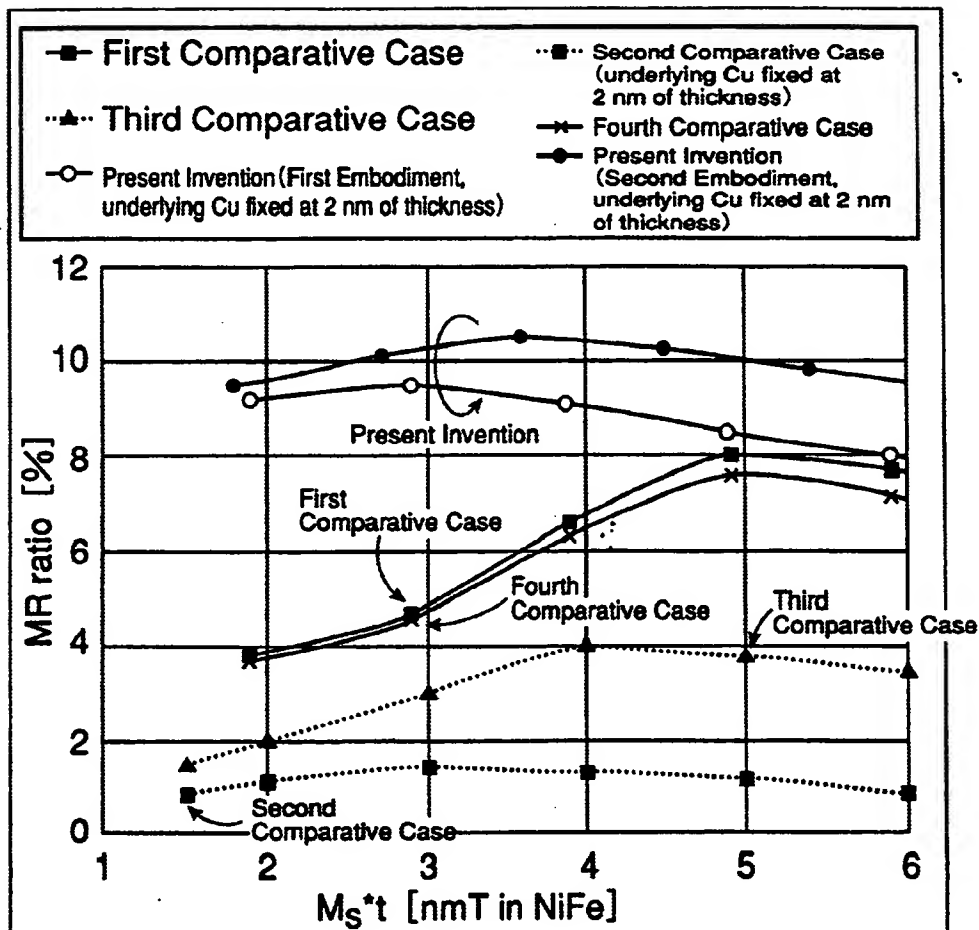


Fig.16

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Fig.17

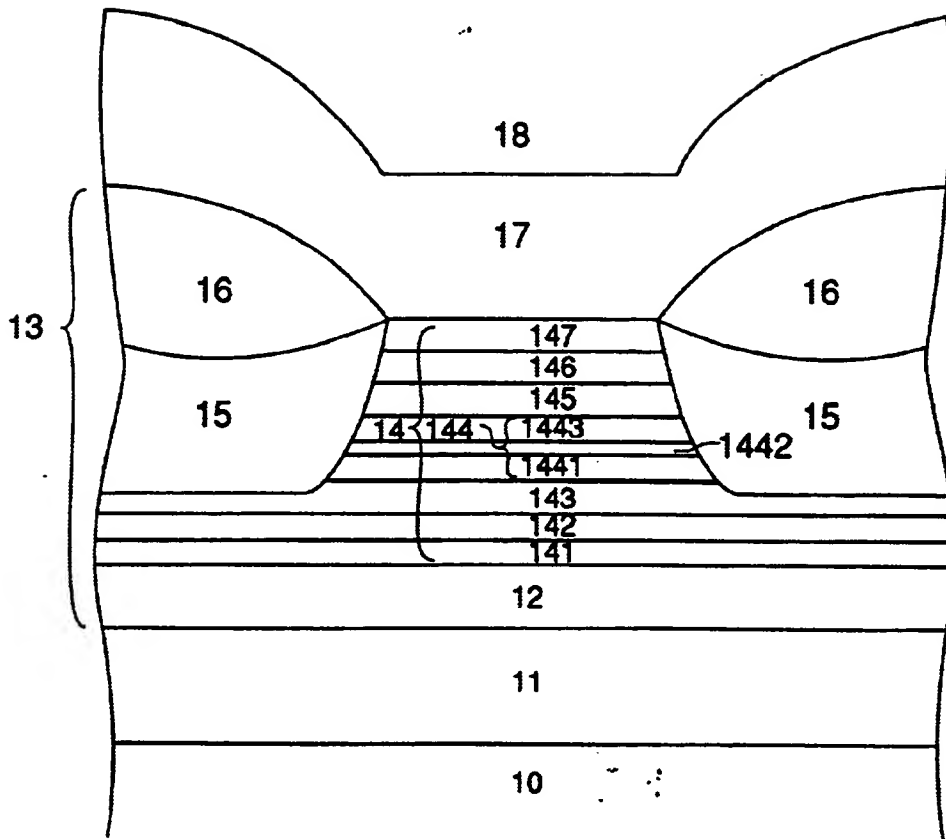
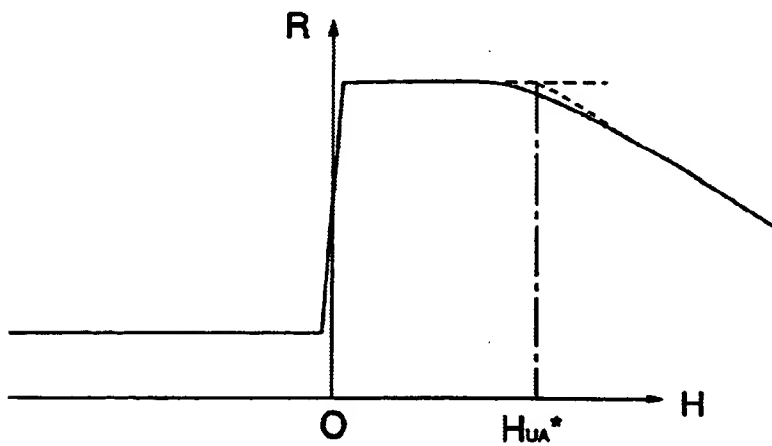


Fig.18



FOOT: 1500/1500

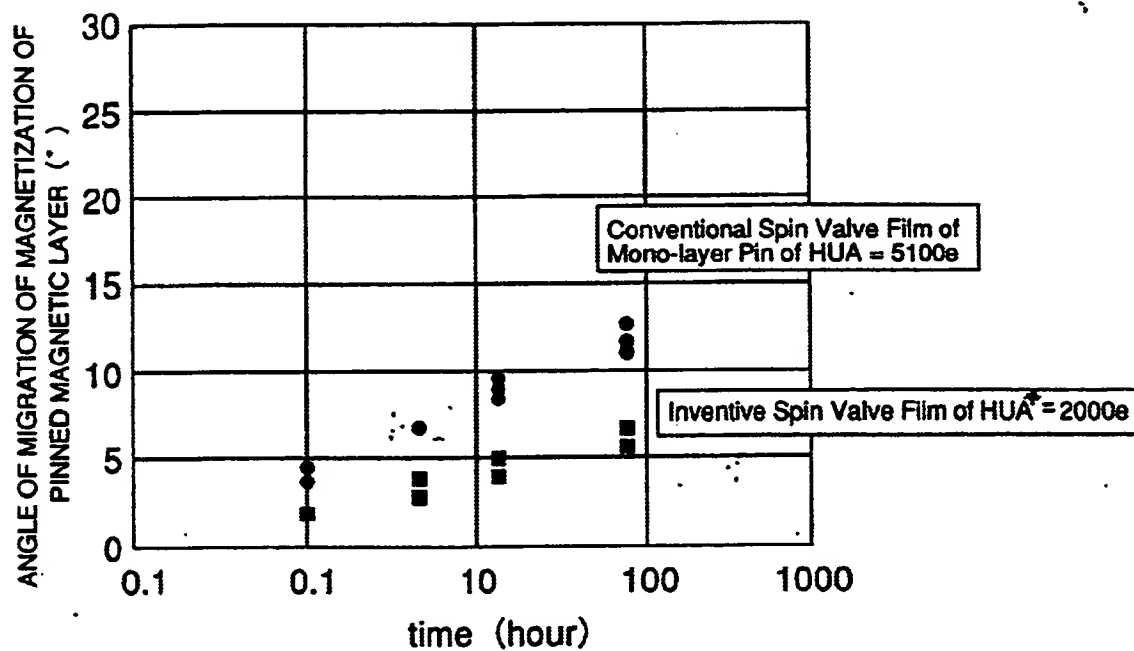
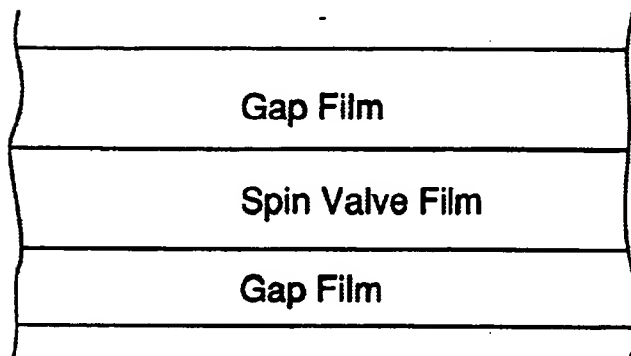
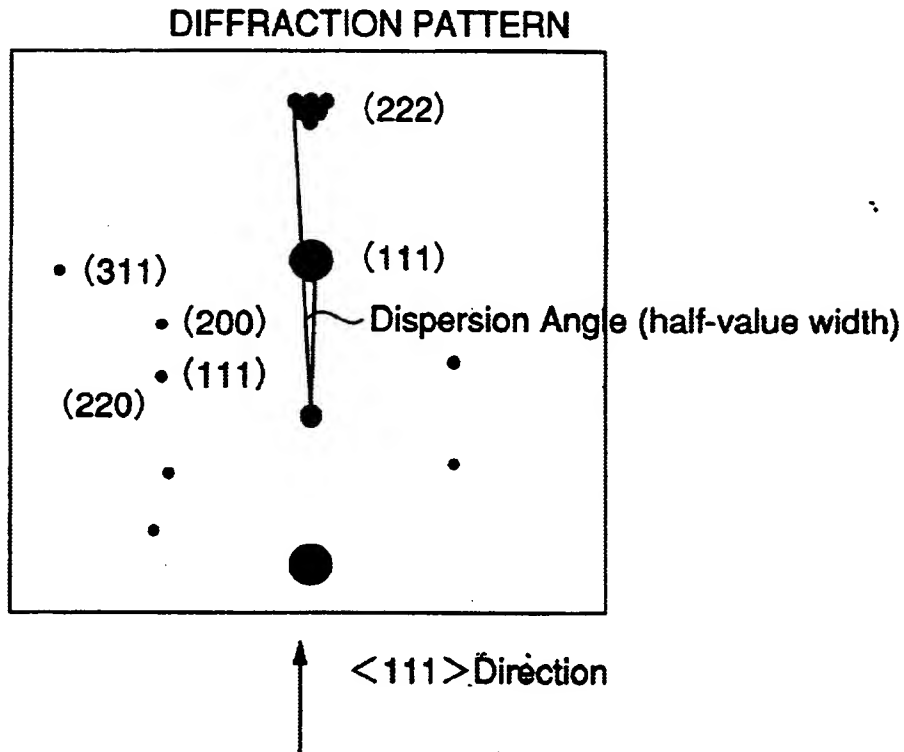


Fig.19

Fig.20



SECTIONAL VIEW OF SPIN VALVE ELEMENT PART

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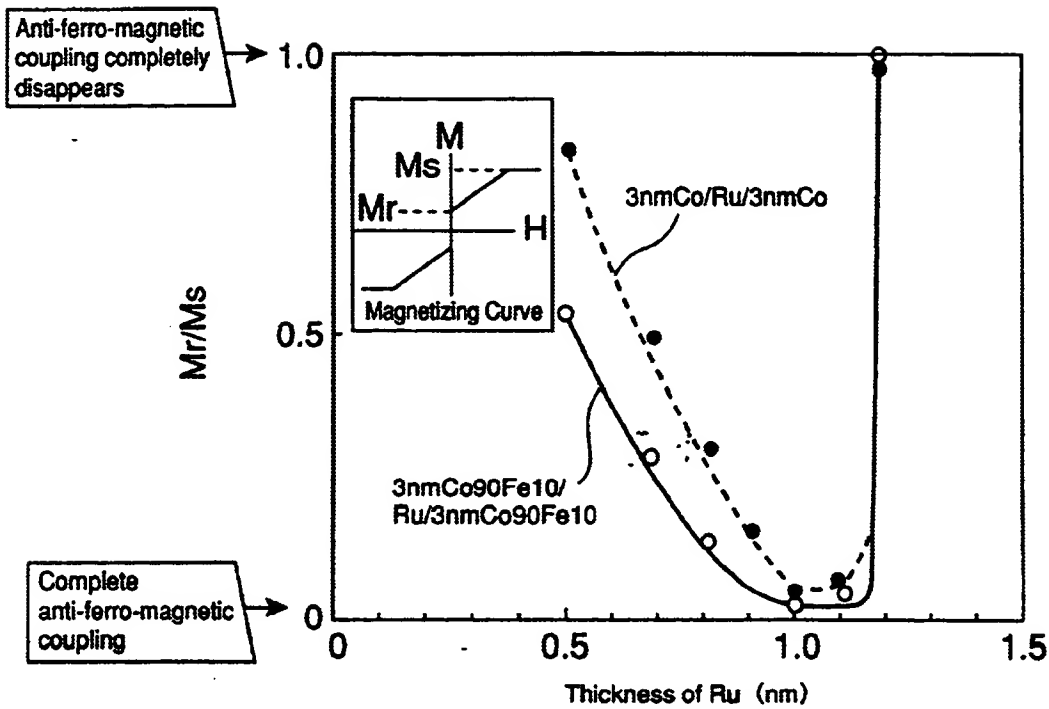


Fig.21

Fig.22A

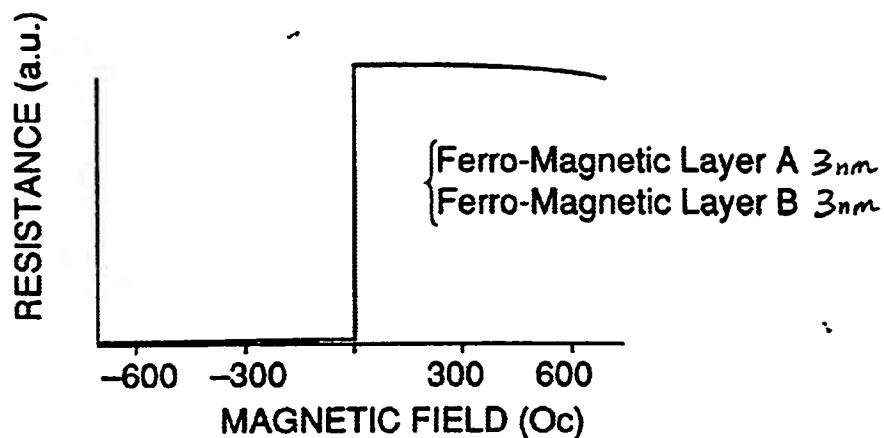


Fig.22B

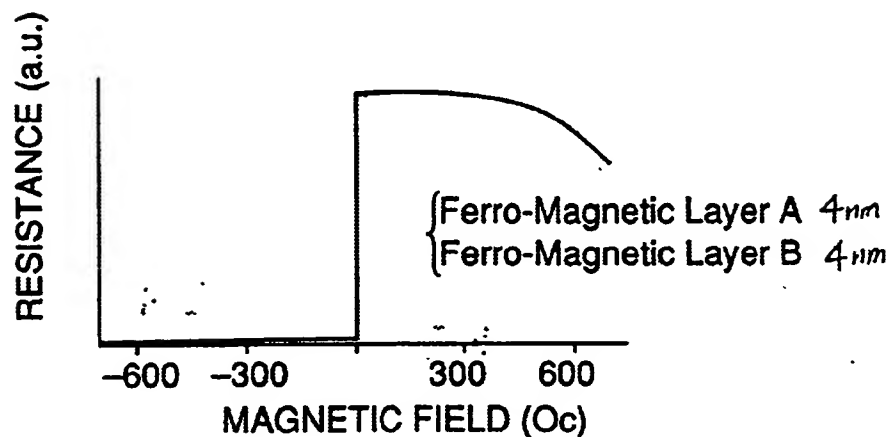
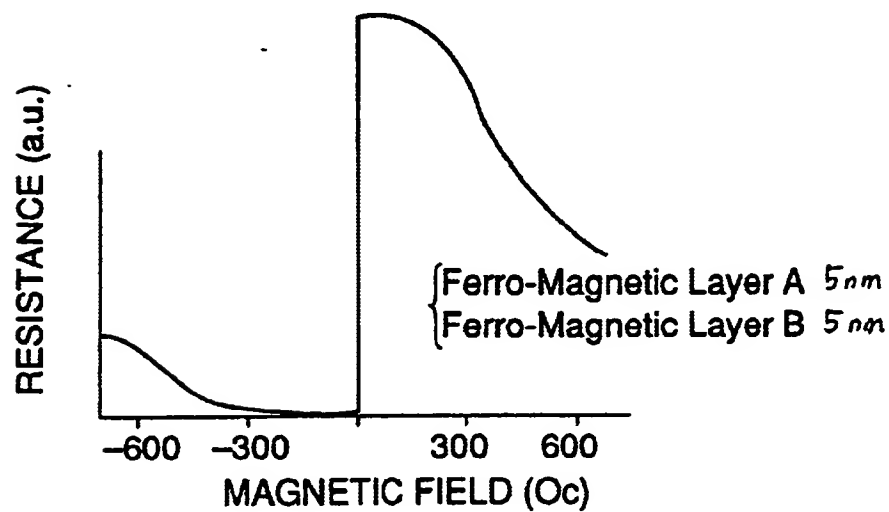


Fig.22C



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Fig.23A

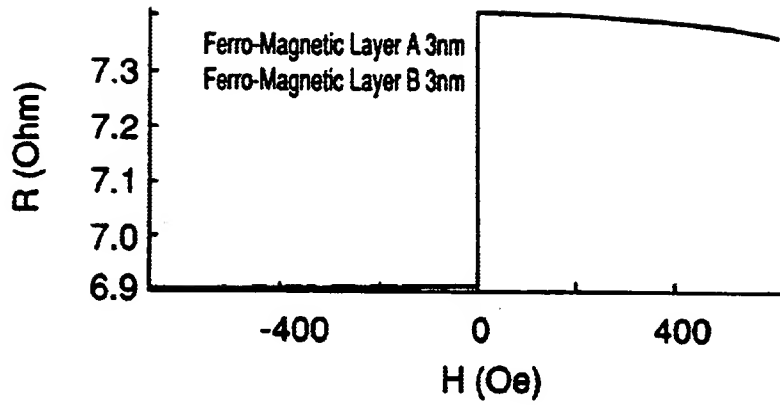


Fig.23B

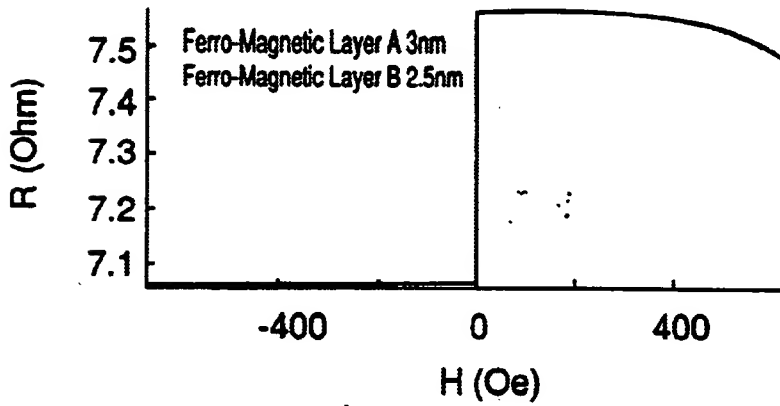


Fig.23C

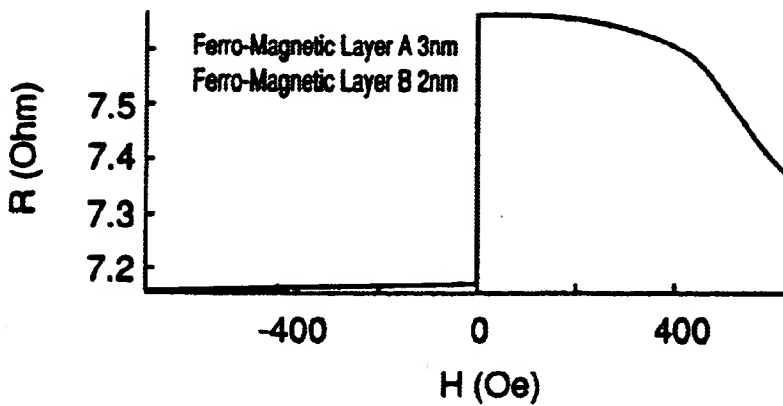


Fig.24A

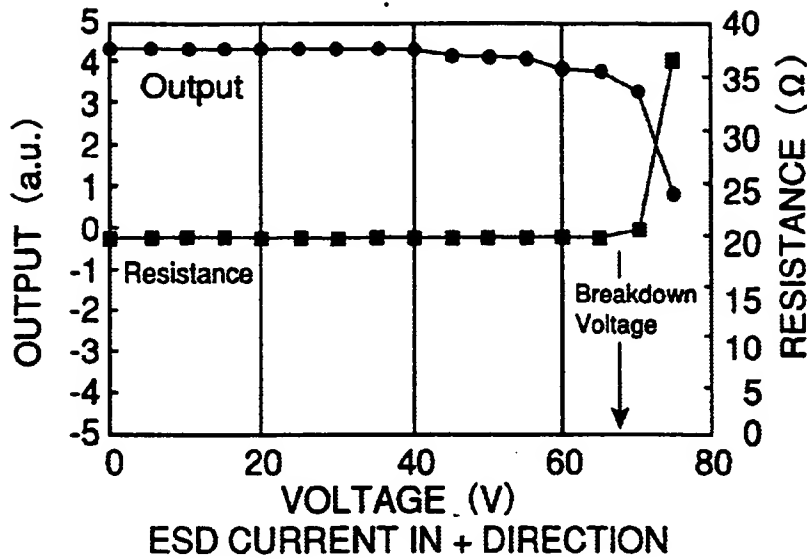
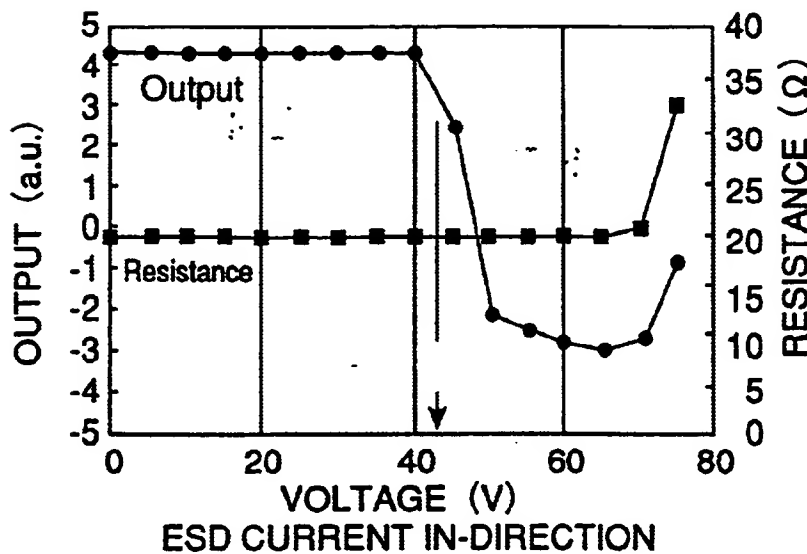


Fig.24B



STRUCTURE OF SV FILM

{ VOLTAGE : ESD Voltage by Human Body Model.
ESD CURRENT : + Direction is direction in which ESD Current
Magnetic Field is applied in the Same Direction with Magnetization
of Ferro-magnetic Layer B }

WHEN THICKNESS OF MAGNETIC LAYER OF
FERRO-MAGNETIC LAYER A IS EQUAL WITH THAT OF
FERRO-MAGNETIC LEYER B

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Fig.25A

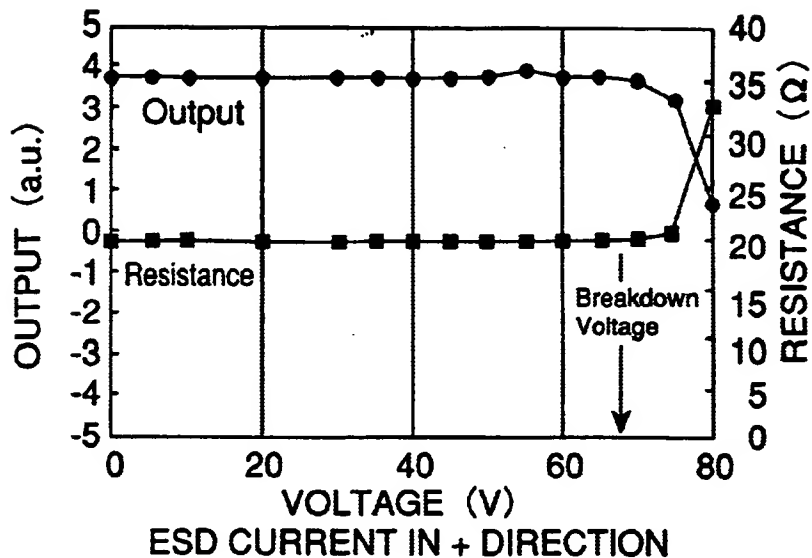
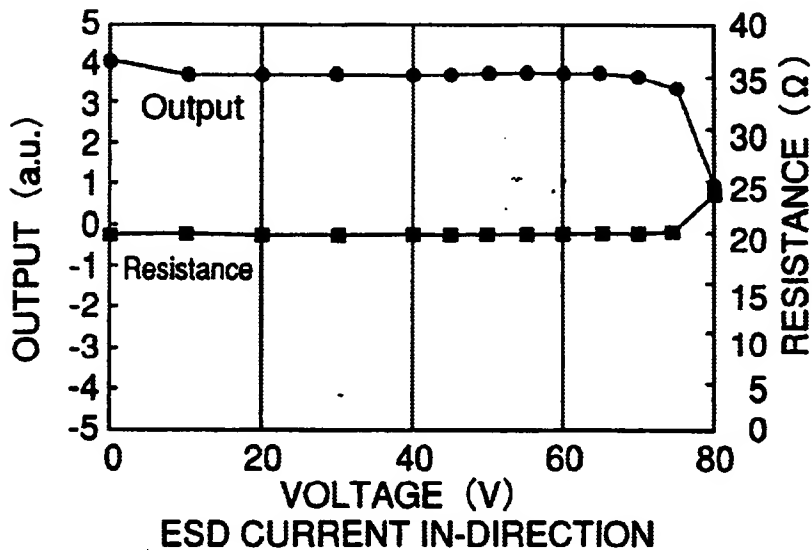


Fig.25B



STRUCTURE OF SV FILM

{ VOLTAGE : ESD Voltage by Human Body Model
ESD CURRENT : + Direction is direction in which ESD Current
Magnetic Field is applied in the Same Direction with Magnetization
of Ferro - magnetic Layer B }

WHEN THICKNESS OF MAGNETIC LAYER OF
FERRO-MAGNETIC LAYER A > THICKNESS OF MAGNETIC
LAYER OF FERRO-MAGNETIC LEYER B

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Fig.26

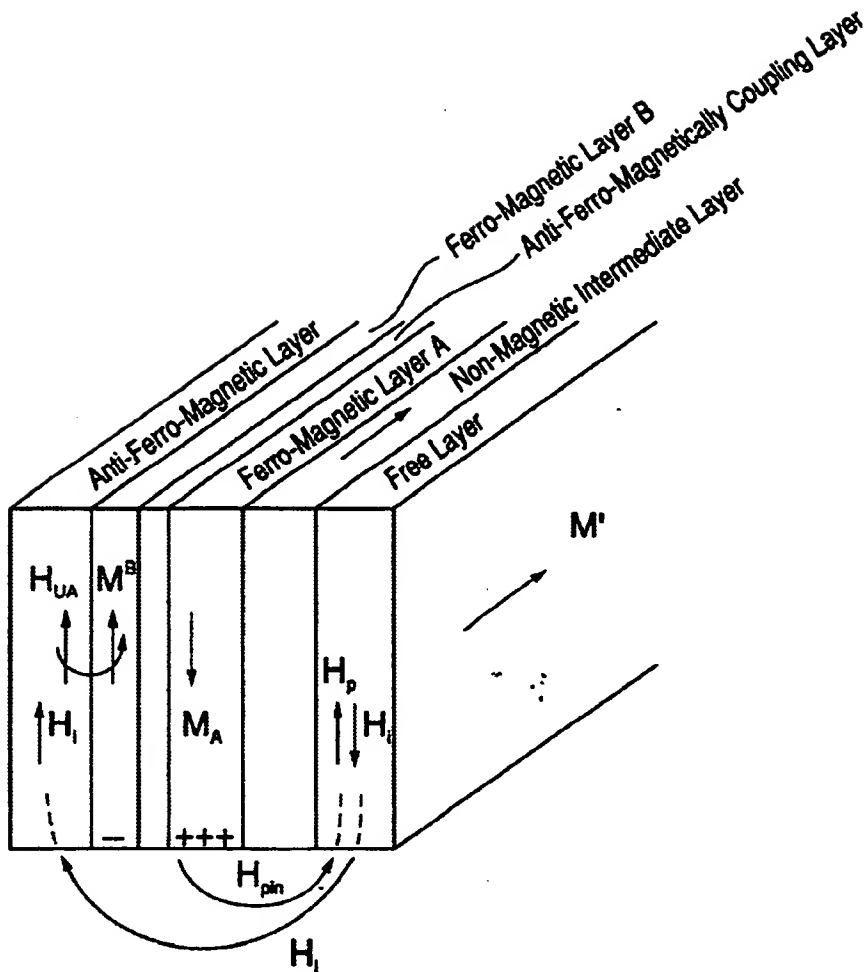
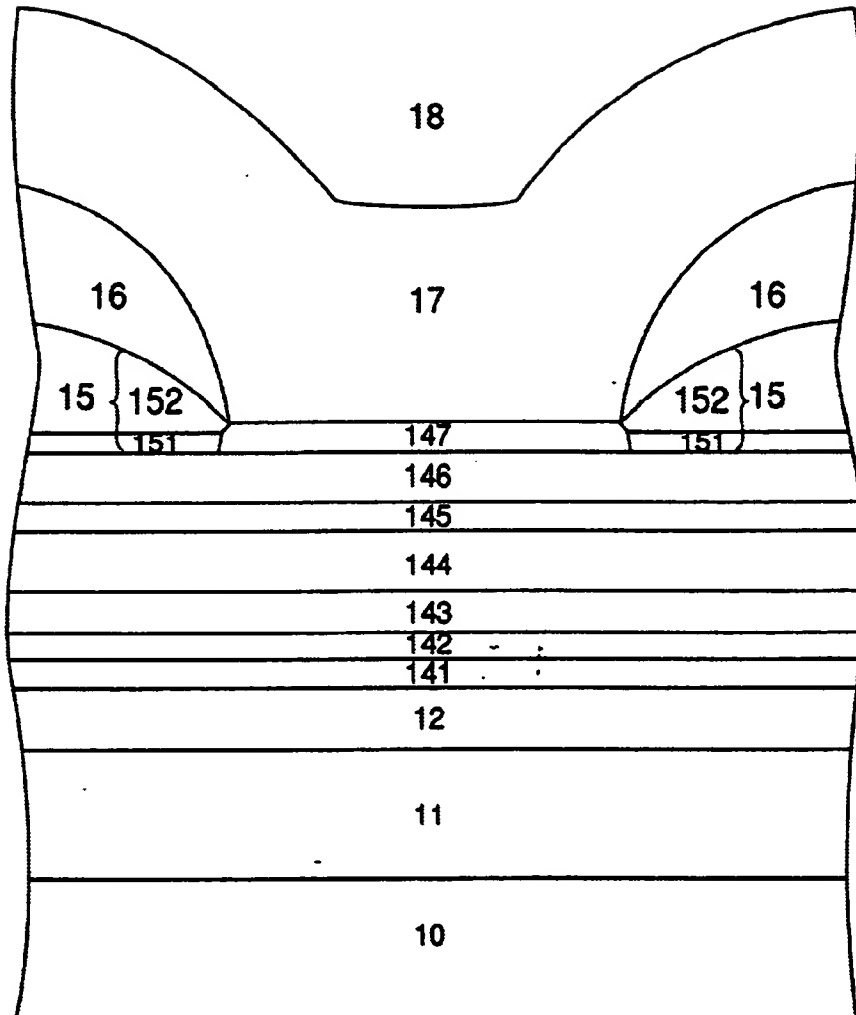


Fig.27



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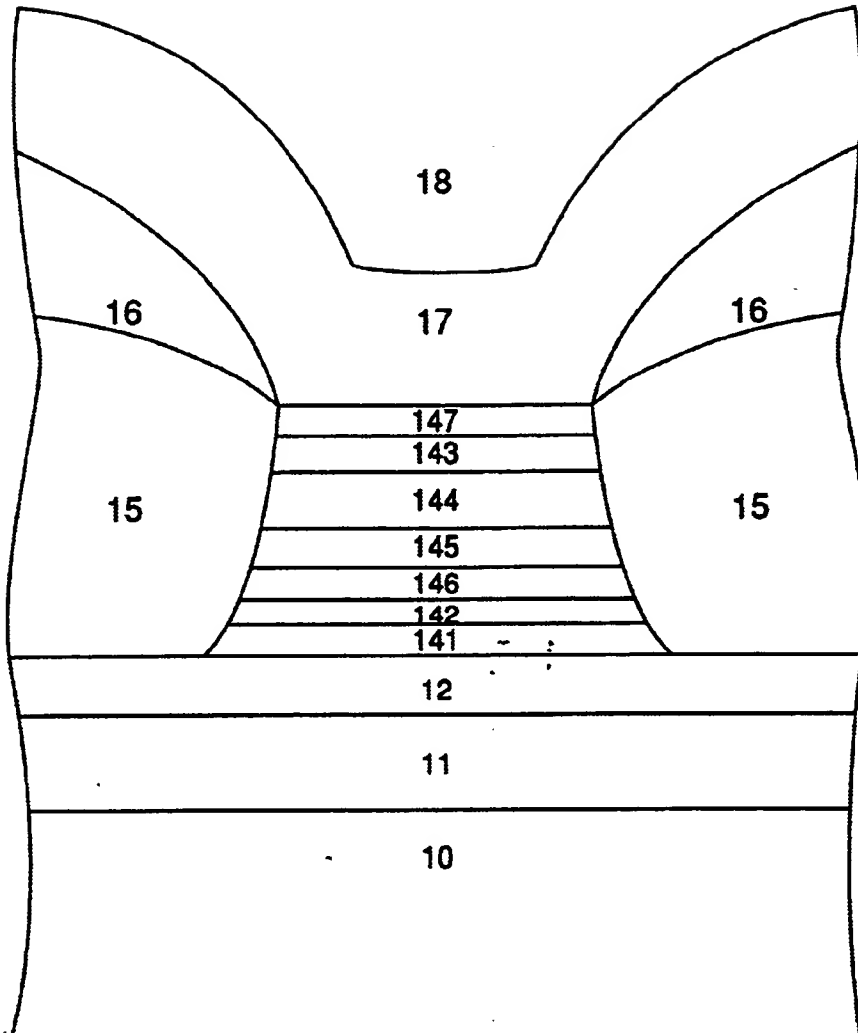


Fig.28

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Fig.29

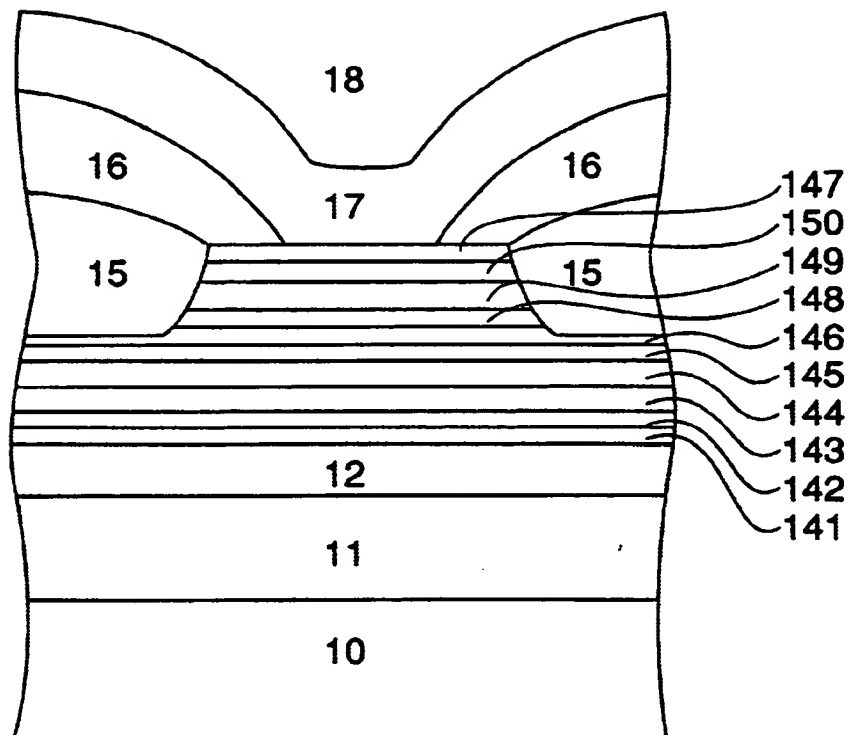
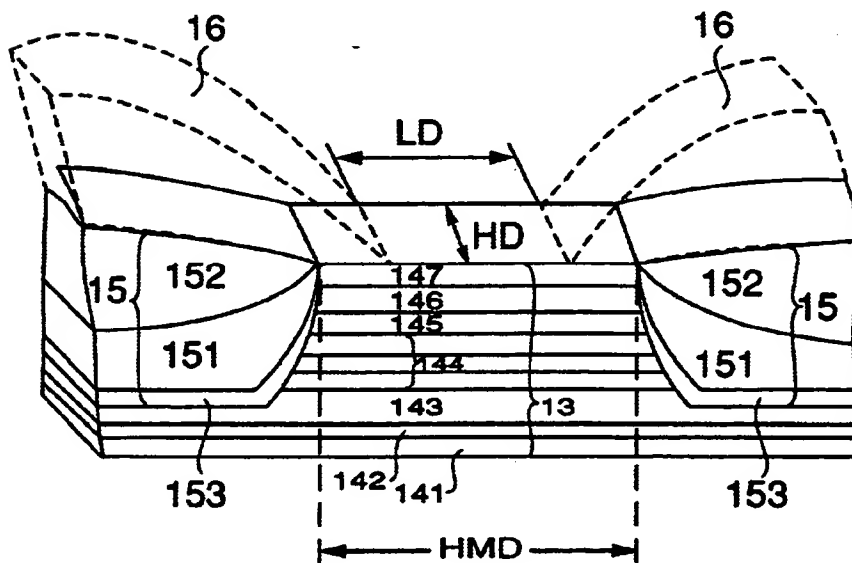
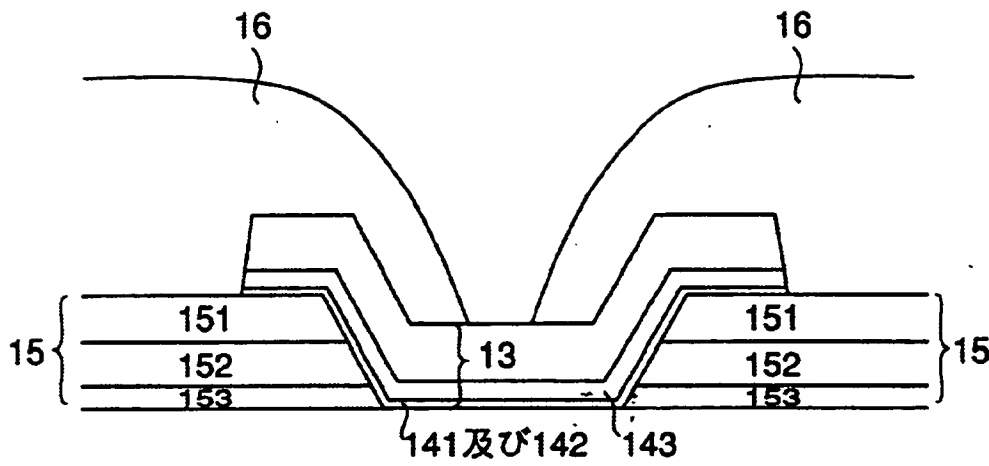


Fig.30



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Fig.31



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Fig.32

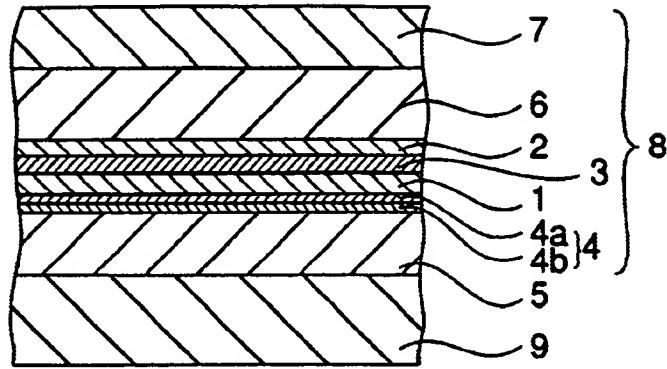


Fig.33

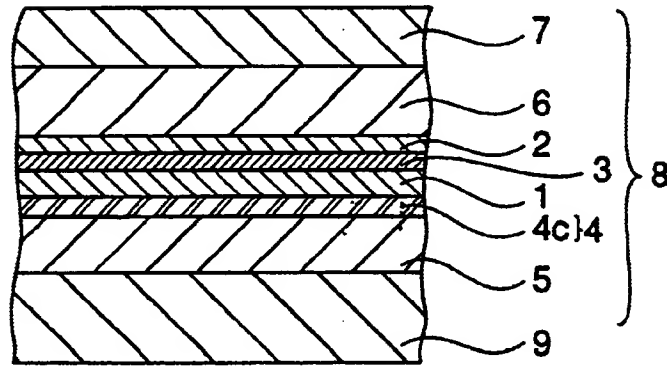


Fig.34

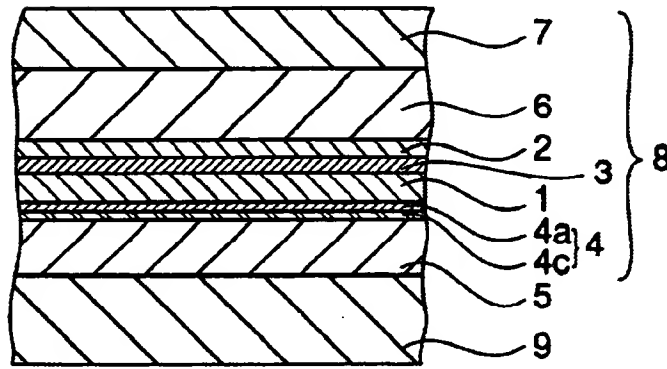


FIG. 32

Fig.35A

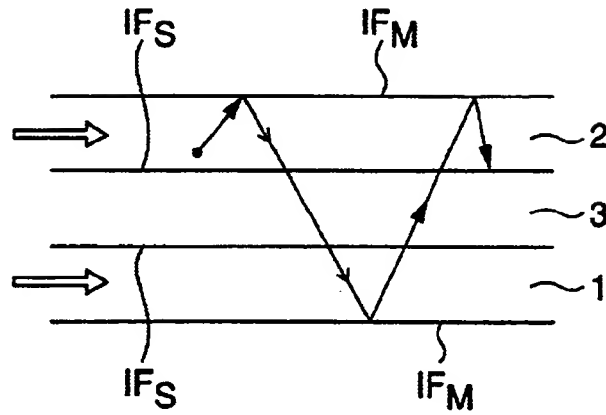


Fig.35B

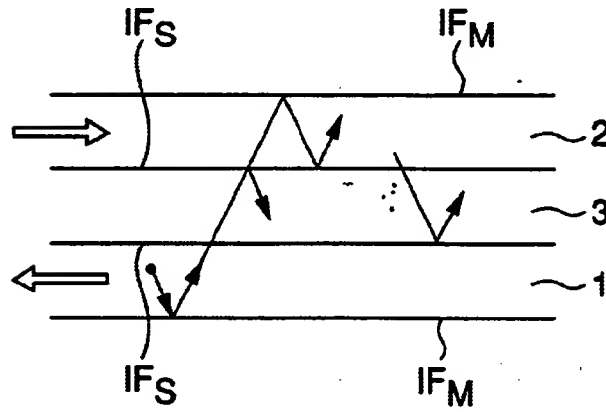
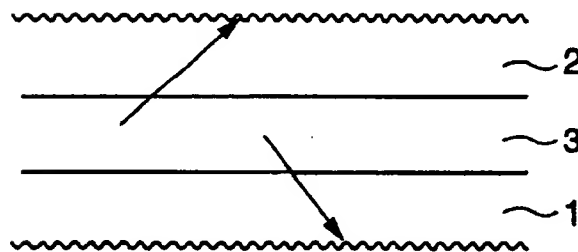


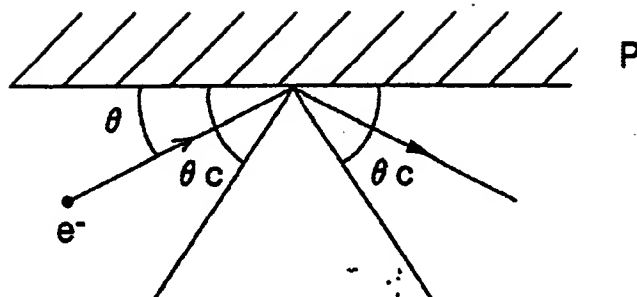
Fig.35C



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100101 522E2060

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Fig.36



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100101 5222660

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Fig.37A

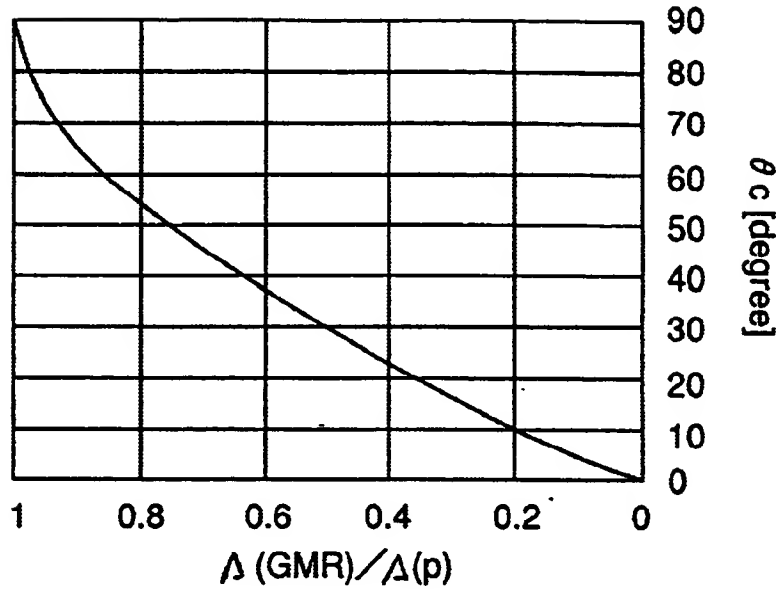
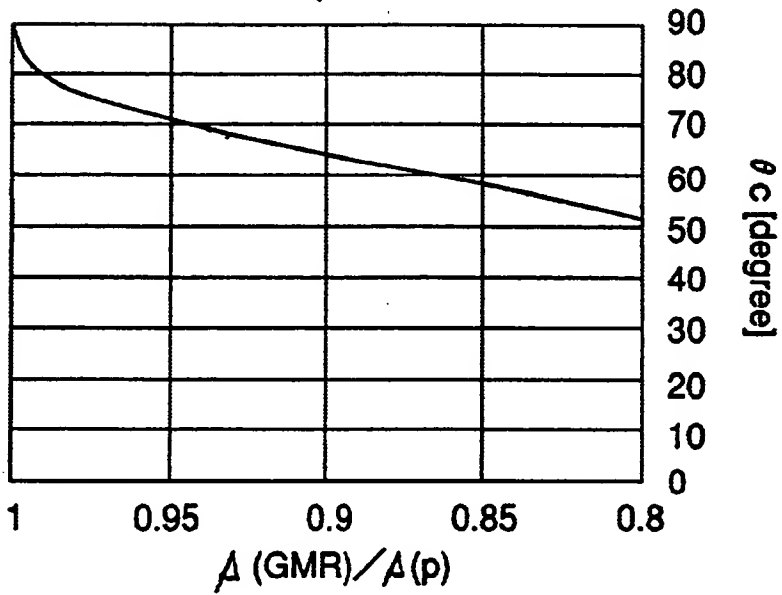


Fig.37B



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Fig.38

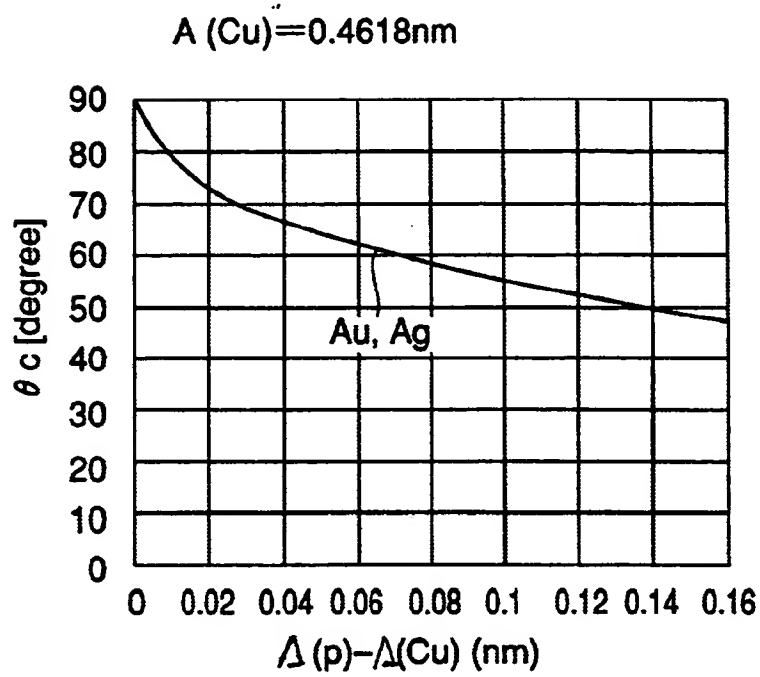
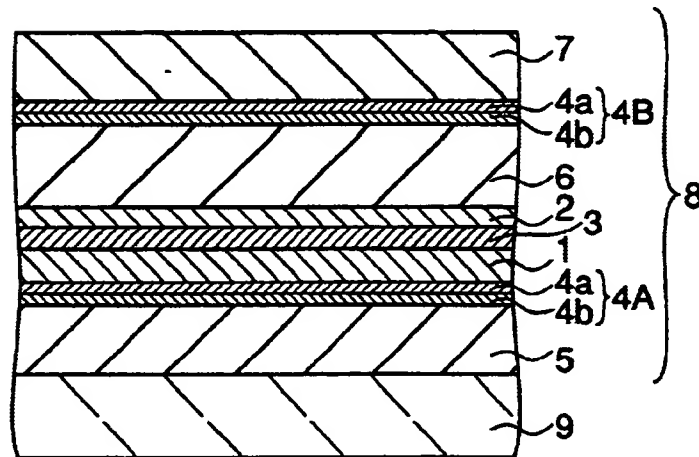


Fig.39



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Fig.40

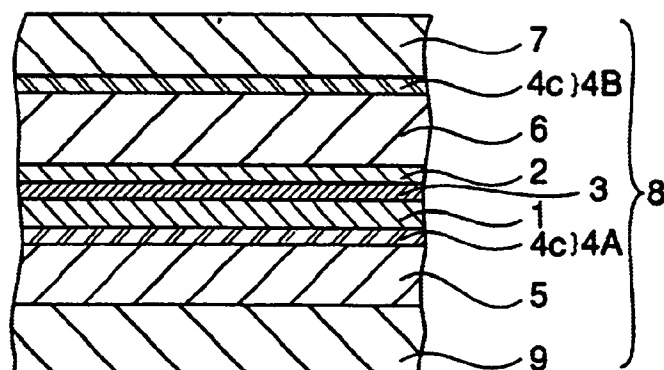


Fig.41

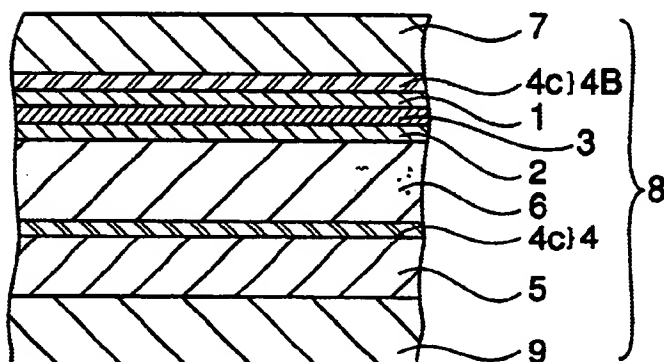
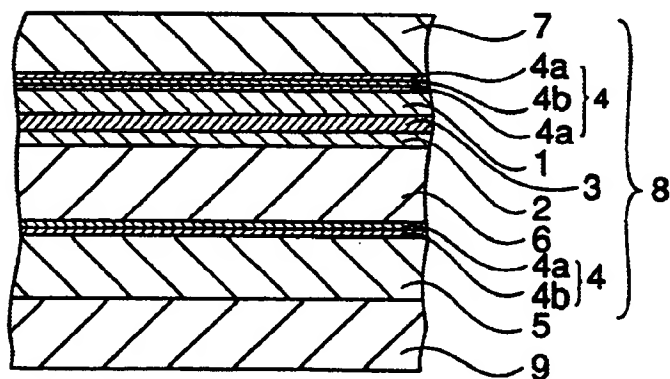


Fig.42



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Fig.43

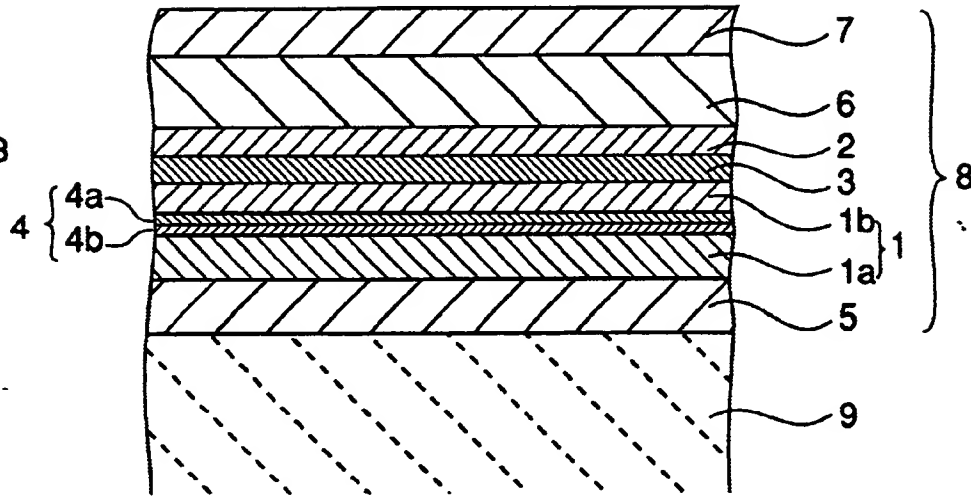


Fig.44

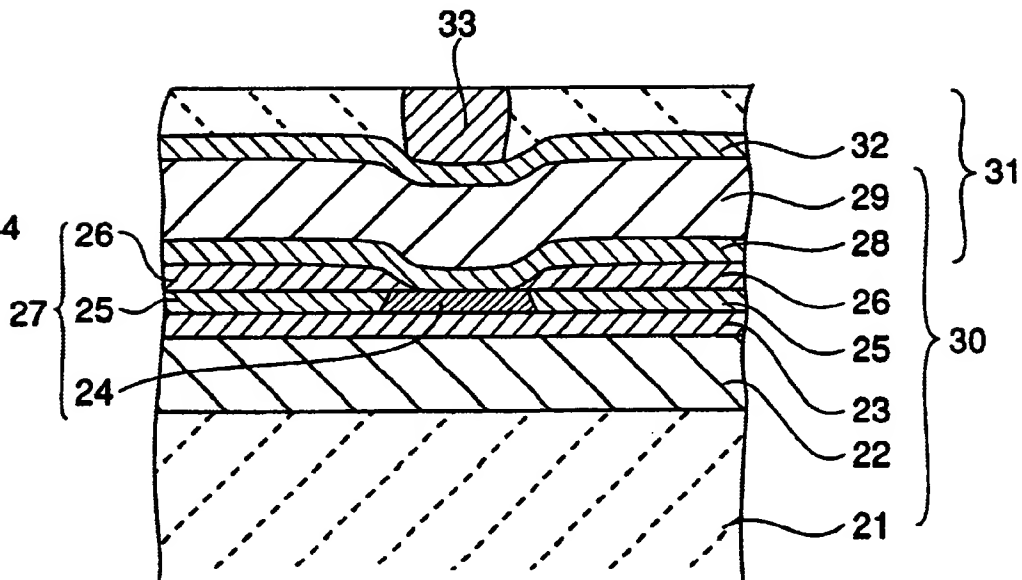


FIG. 43

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Fig.45

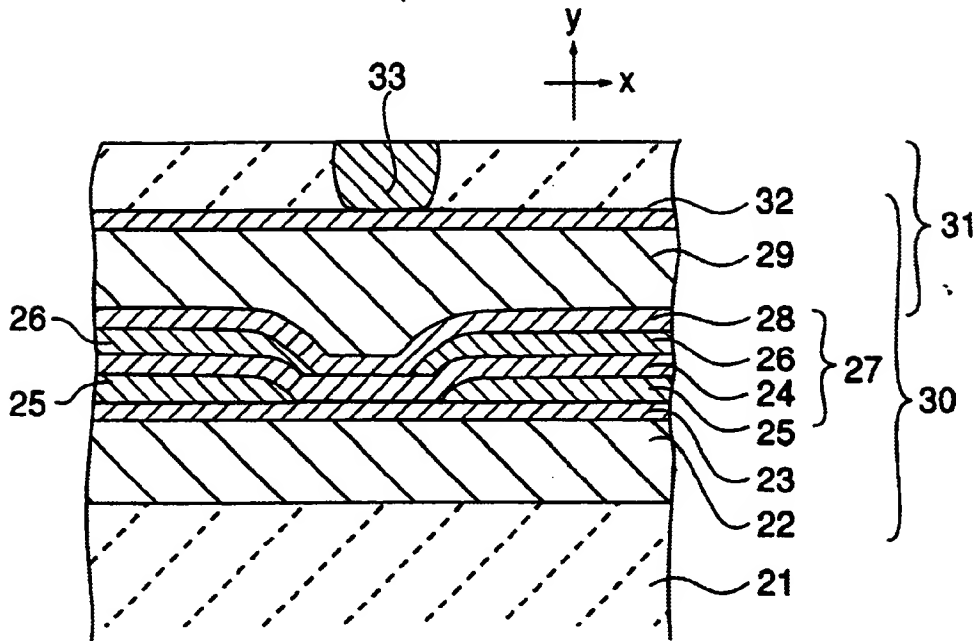
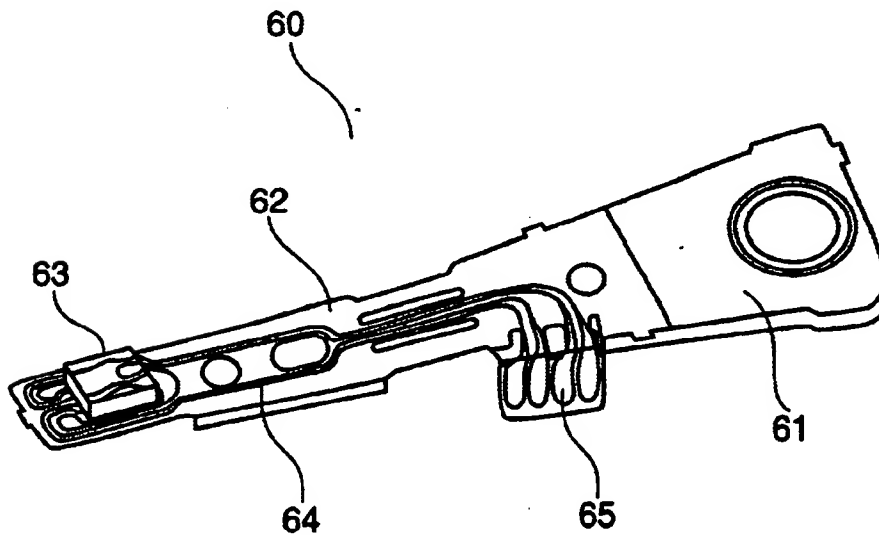


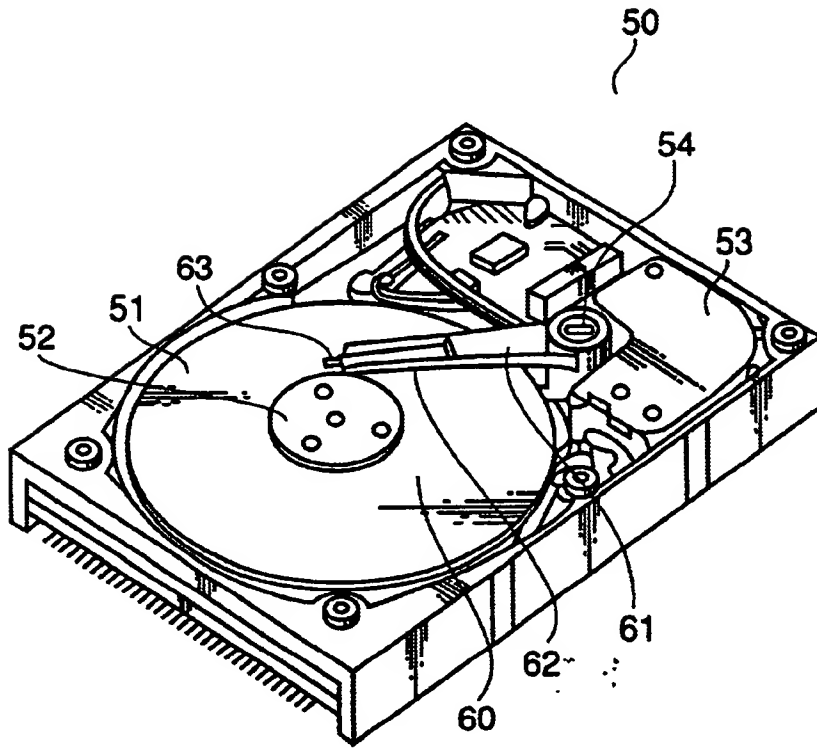
Fig.46



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Fig.47



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43

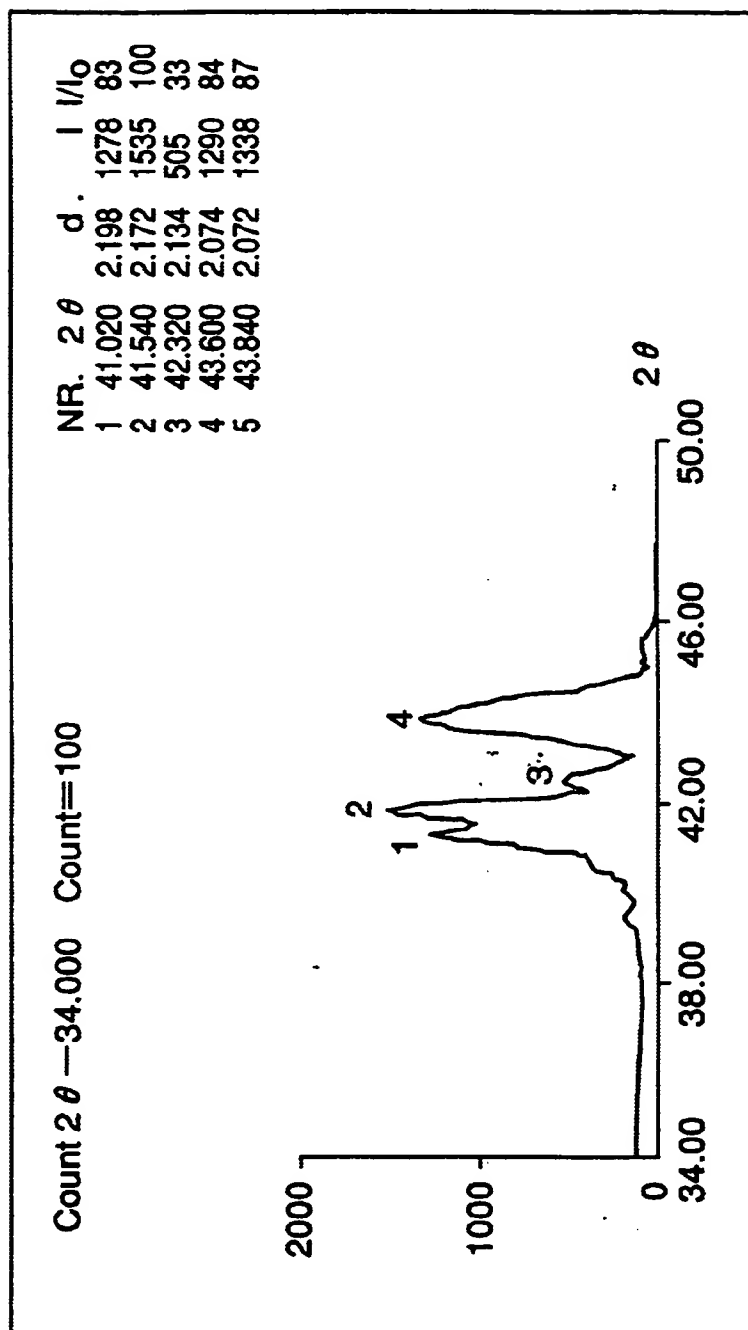
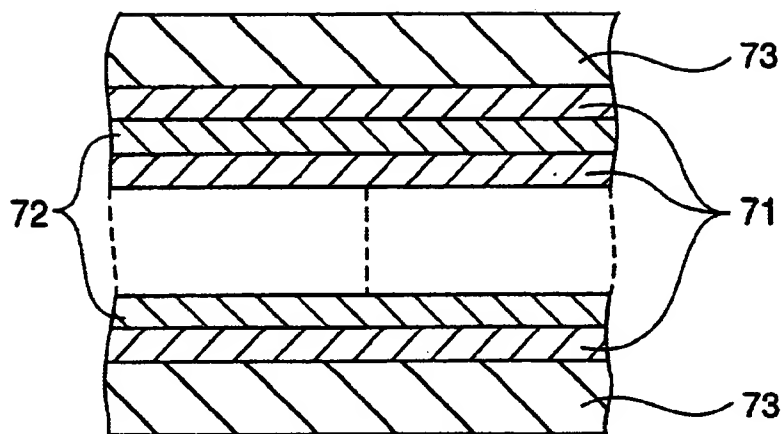
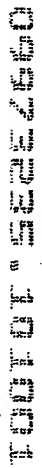


Fig.48

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43

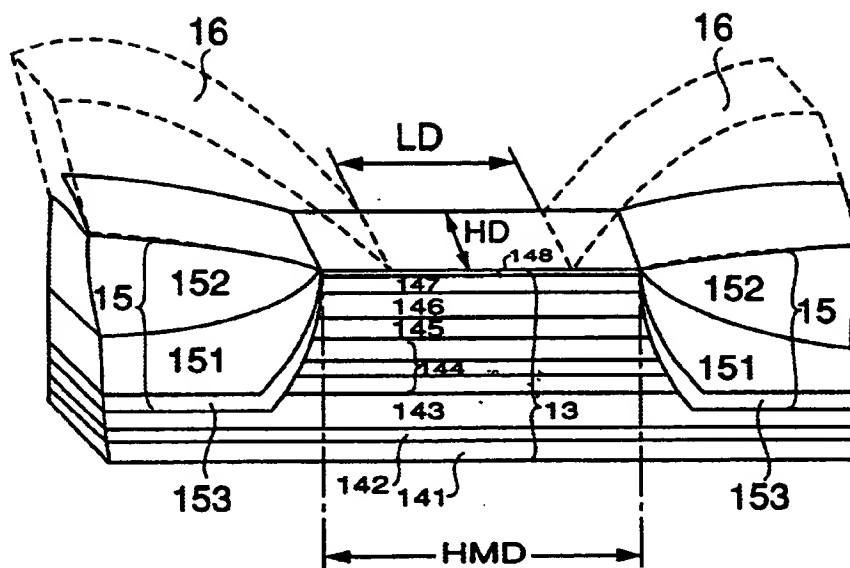
Fig.49





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Fig.51



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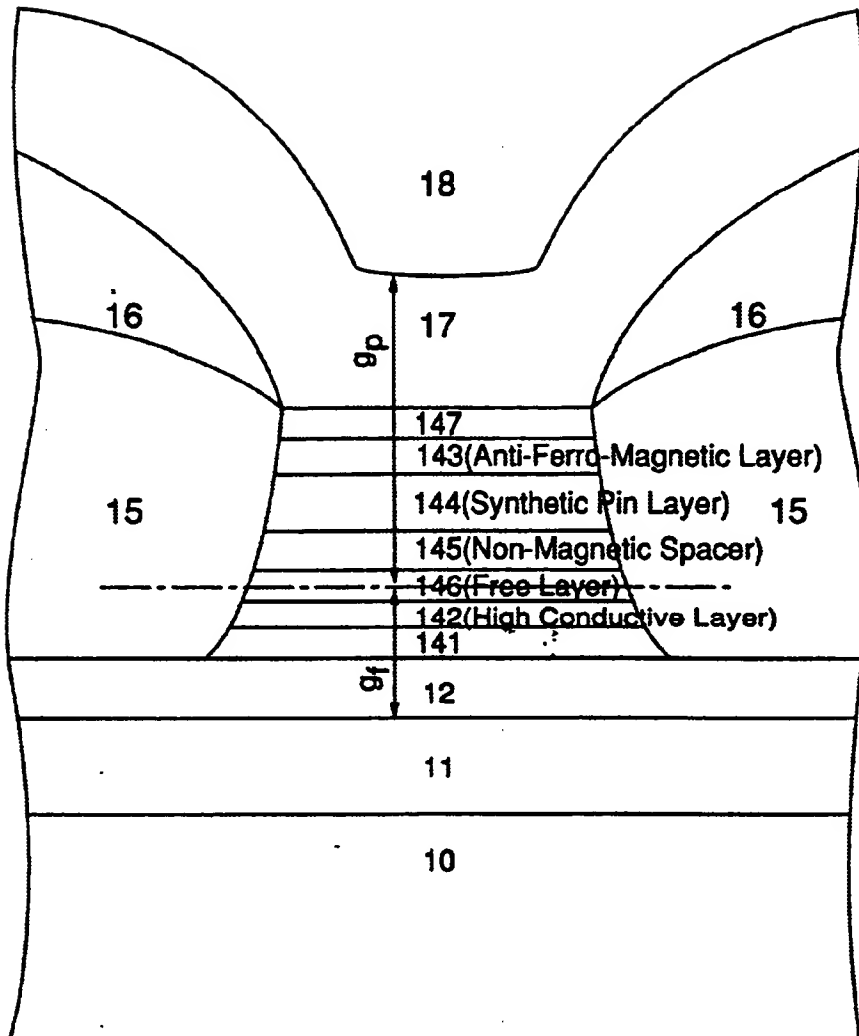


Fig.52

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